SAND2018-0118R

Dirty Bombs and Other Radiological Dispersal Devices

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Sandia National Laboratories is a multimission laboratory managed and operated by National Technology and Engineering Solutions of Sandia LLC, a wholly owned subsidiary of Honeywell International Inc. for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA0003525.

Research Question

Radiological terrorism - what is a dirty bomb and what other forms of radiological weapons have the potential for a non-state actor to use as a Weapon of Mass Destruction (WMD)?

Purpose Statement

The purpose of this paper is to review what a 'dirty bomb" is and what the challenges are to actually developing and utilizing one. Additionally, it will review whether there are other radiological options for the non-state actor desiring to utilize them as a WMD. Integrated in this study and analysis is to determine if a non-state actor has the potential for better access to, and the ability to utilize, certain radiological WMDs.

Literature Review

To delve in to the definition of a dirty bomb and whether or not it is the only option that non-state actors would have if they wish to utilize a radiological form of an WMD, it is necessary to first review the definition and challenges associated with a dirty bomb. Then additional resources must be reviewed to determine if there have been any other types of radiological attacks that might be easier for a non-state actor to implement.

As recently as June 2017, the International Atomic Energy Agency's (IAEA) director, Yukiya Amano, discussed dirty bombs. In the "International Atomic Energy Agency's Director General's Statement at High-level Dialogue on Nuclear Security", Amano describes a dirty bomb as someone taking radioactive material and combining it with a conventional explosive component to create a device that can disperse radioactive materials. (p. 2) Amano goes on to

state: “If one of these was detonated in a major city, it could cause serious damage, loss of life and mass panic.” (p.3)

The statement continues to describe the potential for a terrorist organization to obtain radiological materials that could be used to create and deploy a dirty bomb. Even though risks are identified, the dialogue goes on concerning the mission and purpose of the IAEA and how the organization is working to reduce the risks. Amano says “Our main role in nuclear security is to provide practical assistance, expert advice, equipment, and training to minimize the risk of nuclear and other radioactive material being used in a malicious way.” (p. 4)

The IAEA’s role is important in creating environments where radiological materials are used in a positive way, and that the countries utilizing nuclear power plants, etc. are maintaining a standard of security at those facilities. In another IAEA article titled “Morocco, International Organizations, IAEA Member States Hold Exercise on Response to Dirty Bomb”, it mentions how nuclear power plant accidents are the norm for these types of exercises, but in 2013 a dirty bomb scenario was chosen. (International Atomic Energy Agency, 2013) This switch from nuclear power plants to a dirty bomb exercise is could be an indicator of how the IAEA is changing its preparedness to include responding to RDDs.

The Department of Homeland Security (DHS) has also released a fact sheet concerning radiological attacks to include dirty bombs. They too define a dirty bomb as a type of Radiological Dispersal Device (RDD) that utilizes conventional explosives accompanied by a radiological component. The DHS emphasizes the difficulties with successfully deploying this type of weapons and that the consequences would be more around contamination along with the panic it could generate when people believe they are contaminated. The factsheet also identifies

the most common potential types of radiological materials that we use in our society: (National Academies of Science and Department of Homeland Security, 2004)

Common Radioactive Materials Used in Our Society, identified in this factsheet by the National Academies of Science along with the Department of Homeland Security note:

- Gamma Emitters:
  - Cobalt-60 typically used in cancer therapy; industrial radiography and gauges; food irradiation
  - Cesium 137 used for the same activities as Cobalt-60, but additionally in well logging
  - Iridium 193 used in industrial radiography and medical implants for cancer therapy
- Beta Emitters:
  - Strontium-90 used in Radioisotope Thermoelectric Generators (RTGs) that make electricity in remote areas
- Alpha Emitters:
  - Plutonium-238 used in research; well logging; and in RTGs for space missions
  - Americium-241 used for industrial gauges and well logging (p.2)

The fact sheet provides additional information on what the immediate and long term consequences are, and what proactive and response measures can be taken.

In the article, "Beyond the Dirty Bomb: Re-thinking Radiological Terror", James M Acton, M. Brooke Rogers, and Peter D. Zimmerman discuss how the dirty bomb has been the main focus of radiological WMDs. However, they go on to discuss how in "The murder of Alexander Litvinenko in London in November 2006 by polonium-210 ingestion was likely the first provable act of radiological terror." (p. 151) What is interesting about this occurrence is that it was not spread through dispersal as is typically thought of with radiological WMDs. The victim was murdered by ingesting the radiological substance that caused his death. This brings a whole new perspective to the discussion on dirty bombs as there are challenges to their use and lethality. However, dirty bombs should not be ignored even if their use may not cause extensive death. The cost for decontamination; economic losses during this process; and the fear that

would be instilled into the public concerning returning to the decontaminated location may result in a high financial cost. (Acton 2007)

An investigation by British authorities of Alexander's death suggests that he ingested the radiological material not only once, but twice that may have been delivered by KGB agents. High levels of radiological materials were found in the hotel lavatory where two KGB agents had visited, but Alexander never entered the restroom. (Alloca 2006)While there are still investigations around Alexander's death, it demonstrates that it is possible to for a motivated person or organization to access radiological materials and deliver them.

Furthermore, what the case of Alexander Litvinenko demonstrates is that if even a small amount of radiological material can be delivered via ingestion, it can prove much more deadly than the contamination that could be delivered via a dirty bomb. The challenge to the non-state actor desiring to use the ingestion delivery method is how to actually have a successful distribution process. Even with that challenge, there are some barriers with the ingestion model versus a dirty bomb. However, with ingestion, the available material that can be used is greatly broadened. According to the Acton, Rogers, and Zimmerman article with delivery via ingestion "any type of radioactive source – alpha, beta or gamma – could be employed" (James M. Acton, 2007) Alpha sources may be easier for a non-state actor to obtain as they have less strict regulatory control than other sources such as beta and gamma radiological sources. In fact, there was an occurrence during 2002 in Nigeria where 2 alpha sources (commonly use in coal, gas, and oil prospecting) were stolen and later found in Europe with scrap metal materials. (p. 153) Other sources such as californium-252 may be allowed for use at Universities (where security could be less robust), and even smoke detector manufacturers could have larger stores of americium-241 at their facilities. Improved security at facilities that store or utilize large

quantities of radiological material; government preparedness; and effective response plans for both dirty bomb explosions and attacks via ingestion, would be necessary to help reduce the use by a non-state actor.

In addition to the physical damage results of a RDD, we must also consider the psychological effects such an attack could generate. In the article, "The Social and Psychological Impact of Radiological Terrorism", authored by Igor Khripunov these effects are presented. Since an attack with an RDD could be expected to generate social and psychological issues, Khripunov suggests the importance of "Coming to terms with the psychological and social dimensions of radiological attacks is thus a matter of considerable importance for those entrusted with homeland security." (p. 275) Igor goes on to explain how with it's colorless, odorless, and tasteless properties radiological attacks along with the need for special equipment to detect its presence, can cause fear if an attack (or even the perceived risk of an attack) were to occur.

Because of those factors listed above, Khripunov states that RDDs are a "terrorist weapon of choice" (p. 276) The RDD requires less technical expertise and components are typically more readily available than those for nuclear weapons. Additionally, the development of nuclear weapons; their use during World War II; and the nuclear threat during the Cold War assisted in the creation of public awareness (and wariness) of radiological threats.

While dirty bombs may be difficult to create, Igor suggests that suicide bombers (since there is no concern for exposure/loss of life) could be a way to deploy RDD's. That is if they were able to obtain material and get to their location without dying from radiological poisoning before they could carry out their mission. He goes on to explain that the following radioisotopes, some of which are in commercial use, are most likely to be used in an RDD: Co-60, cesium-137, iridium-192, strontium-90 (Sr-90), plutonium-238 (Pu-238), americium-242 (Am-

242), and californium-252 (Cf-252) with each type having specific challenges to handling as well as effectiveness. (p. 281)

In the article "Does Intent equal Capability? Al-Qaeda and Weapons of Mass Destruction", Sammy Salama and Lydia Hansell discuss al Qaeda and its affiliates and their interest in obtaining WMDs. The evidence is there suggesting al Qaida has tried to procure radiological materials, but there has been no successful attempt verified. However, "British authorities claimed to have discovered documents suggesting that the network had constructed a radiological dispersion device, or "dirty bomb," at an unspecified location in Afghanistan." (p. 620) While these types of statements are just claims, it does bring attention to the possibility that there is a concerted effort by these types of organizations to obtain radiological materials and utilize a dirty bomb. The authors continue with several other reports of attempts to obtain these types of materials and a supposed plot to detonate a dirty bomb within the United States.

There are also al Qaeda websites that provide information on how to "manufacture CBRN agents." One site was reviewed by technical experts and "as for the various postings dealing with nuclear or radiological weapons, one is mainly informational and appears to be a translation of a document, which is currently posted on various American websites. (p. 633) A second article, which surveys international instances of radiological contaminations from 1945 to 1987, discusses the possibility of using Cesium-137 in a radiological dispersal devise (RDD)." (p. 633) The main disconcerting piece of information in this post was that there were outlines of expected damage and a list of potential Western targets. This article also goes in to how, after specialists have reviewed many of these al-Qaeda websites related to WMDs, it became apparent that "al-Qaeda literature does not explore the last three stages of deployment—weaponization, manufacture of munitions, and effective delivery systems—as they lack any real insight into

credible techniques of weaponization and deployment of CBRN agents." (p. 636) Since procurement is just the very beginning in creating and successfully deploying a WMD, it brings in to the picture the challenges that al-Qaeda has in actually using an effective RDD. The most likely large scale detrimental result from utilizing a dirty bomb would be an increase in public panic and economic effects.

Some of the challenges to an RDD identified in the article include the limited area within which an RDD would be effective; and the increased danger of inhalation and ingestion versus those only exposed in the immediate blast area. The more intensive risk is identified as the threat, not from dispersion through an expulsive device, but if the terrorist was able to disperse radiological materials via spraying, vaporization, or burning. (Hansell, 2007)

As an example of the potential panic and economic effects, "A Risk and Economic Analysis of Dirty Bomb Attacks on the Ports of Los Angeles and Long Beach", confers the resulting impacts if a dirty bomb was used in these locations. The sources of radiological materials is discussed to include nuclear waste facilities; medical, research, and industrial facilities; and foreign sources of these materials.

> Rosoff and von Winterfeldt discuss the possibility of access to radiological materials through what is called orphan sources:
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> Significant quantities of radioactive material have been lost, stolen, or abandoned—referred to as "orphan sources"—from U.S. and international facilities. According to an August 2003 General Accounting Office report, since 1998 more than 1,300 radioactive sources have become orphaned in the United States. A primary concern of U.S. and international security experts is the number of orphan sources scattered throughout the former states of the Soviet Union and the security of nuclear facilities in Pakistan, India, and other developing countries. (p. 534)

The authors chose shipping ports as a scenario for evaluation as these provide a prime target for terrorists. Ports tend to be large in size which in itself brings security challenges, they also are usually located near high population areas. A successful attack on a port could not only result in fatalities, but disrupt commerce and supply chains potentially on a world-wide scale. As in some of the other reference materials in this literature review, it is also noted that while a localized explosion of a dirty bomb may result in less damage, if the non-state actors were able to find a way to disperse the materials where they could be inhaled, that could cause much more loss of life. The way in which a delivery method is determined and deployed requires attention not only to the details of creation, but also how it will be taken to the location of activation and choosing the location with the most potential impact. In addition to those immediate fatalities, long-term effects of radiological material exposure and the economic damages may result in an extended attack. The following table from this article outlines the authors estimated range of consequences in their scenario: (p. 541)

Consequences	Medium Scenario	High Scenario	Measure
Blast and acute radiation effects	0–10	0–50	Fatalities
Latent cancers	0–20	0–1,000	Fatalities
Port shutdown and related business losses	0–200 million	30–100 billion	Dollars
Evacuation cost (plume)	Negligible	10–100 million	Dollars
Business loss (plume)	Negligible	1–3 billion	Dollars
Property values (plume)	Negligible	100–200 million	Dollars
Decontamination costs (plume)	10–100 million	10–100 billion	Dollars

Table 1 *Range of Consequence Estimates*

A review of this table emphasizes what seems to be a common thread in the risk analysis of an RDD – the fatalities may be kept to a relatively low number but the financial costs could be very impactful. The prevention of such an attack requires effective countermeasures to detect and prevent the use of an RDD. These may include detection devices at ports as well as the preventing the non-state actor from obtaining the materials at all.

> In Radiological Dispersal Devices for Jihad, Al Venter begins with the following statement:
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> Writing under the alias of Esa al-Hindi in a book titled The Army of Madinah The ambition of British Muslim Dhiren Barot to explode a "dirty" nuclear bomb in Britain is eye-opening. "For the time being we do not have the contacts to enable us to purchase such items," Barot wrote before his arrest. [Medina] in Kashmir, Barot declared that one way to counter "Western interference in Muslim lands" would be to conduct large-scale attacks that might include radiological materials. What sets the RDD apart from weapons employed by other dissident political groupings is that al-Qaeda and, by some accounts, now ISIS (ISIL) have shown an unusual interest in these weapons. (p.59)

It also goes in to statements by al-Qaeda members concerning RDDs plus several attempted uses by other organizations of an RDD. This includes a bomb containing caseium-137 that fortunately was never detonated; one near Chechnya that was not detonated but included materials from a local nuclear isotope facility; and the mentioning by al-Qaeda personnel in United States' custody making claims that their organization already knows how to make a dirty bomb incorporating caseium-137 along with the consideration of obtaining spent fuel cells from old Russian nuclear submarines. The challenge, even if the materials were obtained, would be how to get the materials into the United States, with one viable potential option being where Mexico borders the United States.

This article also mentions "It is known in the West that such industrial and medical sources disappear at an alarming rate all over the world." (Venter, 2015) This certainly can set

off alarms about the security needed to prevent radiological materials from disappearing and providing potential resources for a non-state actor.

Another discussion of that ability for a non-state actor to obtain radiological materials is noted in Jane's "SPECIAL REPORT - Weapons of Mass Disruption: Radiological Devices". It describes how two nuclear scientists in Afghanistan were approached by al-Qaeda to assist in them in obtaining radiological materials. These two scientists were able to guide British specialists to an area in Kabul where the Taliban had stashed away radioactive materials in a Kabul mental hospital. (Jane's, 2002) The article continues with information on the investment the United States has made in detection equipment not only for homeland use, but also at Russian border crossings.

In addition to obtaining materials for an RDD from existing sources; another consideration is an attack on a nuclear power plant. In Michael Eisenstadt and Omar Mukhlis article, The Potential for Radiological Terrorism by al-Qaeda and the Islamic State, he mentions that supposedly some groups have shown an interest in using an attack on a power plant to disperse radiological materials over a broad area. (Mukhlis, 2016) While this article mentions the difficulties around handling radiological materials and the challenges with terrorist groups in effectively deploying an RDD, he also describes recent evidence that terrorist groups continue to show interest in RDDs.

A couple of examples Michael Eisenstadt and Omar Mukhlis provide are:

> Concerns about nonconventional terrorism at the Rio Summer Olympics, and reports that persons involved in the November 2015 Islamic State (IS) attack in Paris had conducted video surveillance of a scientist employed at the Belgian Nuclear Research Center, have revived fears that terrorist groups may be interested in building a "dirty bomb" using radioactive materials…IS has shown an interest in nonconventional weapons, and used chemical weapons in combat in Syria and Iraq. So, when IS overran Mosul University in June 2014 and reportedly gained access to 40 kg of nuclear materials in the school's

> laboratories, concerns were raised that these materials might be used in an RDD. The discovery of the previously mentioned surveillance tape after the November 2015 Paris bombings seemed to confirm these fears that IS may be interested in building a dirty bomb. (p.1-2)

Even though it may difficult for a terrorist to incorporate radiological materials in to a weapon, it may still be an area where they continue to try and pursue. The nature of terrorism is to inflict terror and an RDD could accomplish this. With the potential for extensive psychological and economic effects in addition to long term medical problems, RDD's can be of continued interest to terrorists. (Mukhlis, 2016)

While an RDD or attack on a nuclear power plant deployment by a non-state actor may seem unlikely, the possibility cannot be completely dismissed.

Methodology

This paper's purpose is to provide analysis and insight around the definition of a dirty bomb and whether there are other forms of RDD's that could potentially be effective when used by a terrorist. Additionally, an analyses of the challenges related to a terrorist actually developing and deploying a dirty bomb are examined.

The selection process for the reference materials consulted in this paper were based on content related to the subject area; the use of peer reviewed and scholarly articles; accompanied by information from agencies responsible for either radiological monitoring or incident preparedness.

In the process of answering the research question qualitative, exploratory, and case study methodologies are utilized. Qualitative and exploratory research provide a stable base of information to aide in the review and analysis process. By reviewing available case studies it allows for examination of real world situations related to RDDs along with any known attempts to obtain materials to develop an RDD.

Findings & Analysis

In an effort to begin analysis on dirty bombs it was first necessary to identify the definition of a dirty bomb. According to the IAEA, a dirty bomb is a weapon where radiological materials are combined with conventional explosives in an effort to disperse the radiological materials. A dirty bomb falls under the umbrella of RDDs that includes other types of devices capable of causing the dispersal of radiological materials. Some examples of RDDs outside the term of dirty bombs include devices that could use powder forms, aerosols, or simply leaving radiological materials in public space. (Department of Homeland Security, 2004) An important point to remember is that RDDs are not a nuclear weapon; some key differences include the magnitude and type of explosion, the amount of fatalities, as well as the size of an area that would be affected. These factors are significantly greater with use of a nuclear weapon. (Department of Homeland Security, 2004) Public panic accompanied by economic effects are the main potential outcomes with the use of an RDD.

With an understanding the RDD definition, including dirty bombs, it is possible to delve further in to the challenges and possibility of use. This information along with documented cases of terrorist interest, attempts to obtain materials, or actual possession of materials necessary for development and deployment of an RDD provide the data necessary for analysis.

Potential sources for radiological materials include universities, medical facilities, industry (coal and gas in particular), spent fuel cells old from Soviet nuclear submarines, and manufacturing facilities could provide the materials necessary for an adversary to create some type of RDD. The access to the above listed sources can vary from areas with high security to

those where there could be less stringent security capabilities such as universities. (James M. Acton, 2007)

This highlights the potential for terrorists to obtain materials from areas where security and tracking is less rigorous. However, having access and obtaining these materials is just the beginning stage in the development of an RDD – the organization must also have the resources to actually find a way to incorporate those materials in to an effective dispersal device. An additional challenge with radiological materials is being able to properly and safely handle them until they can be incorporated in to a device and delivered. One of the barriers to effective deployment of an RDD includes detection devices that have been developed and are utilized in locations such as points of entry.

There are also a variety of types of materials, each with their own attributes, availability, and potential for damage. While there is some opportunity for fatalities with an RDD, the more long-term damages revolve around the amount of fear and psychological effects as well as the economic costs and potential long-term medical problems. Some of the economic damages are related to evacuations, clean-up, losses to businesses, and decreases in property value that can continue for an extensive period of time. Both psychological and economic consequences should be considered when evaluating the total effectiveness of an RDD attack.

According to multiple sources there is documented interest by terrorist organizations in employing an RDD as an option. Additionally, online terrorist websites reportedly contain information around the use of RDDs and al-Qaeda personnel that were in the custody of the U.S. claimed that the organization already had the know-how to create a dirty bomb utilizing caseium-137. (Venter, 2015)

Conclusion

The research for this paper indicates that it is difficult to single out dirty bombs from other types of RDDs. All RDDs can be a potential option for terrorists desiring to use them for their mission. It appears that the extensive use of the term dirty bomb has cluttered concerns around the use of other types of RDDs.

The reality is that there are terrorists with an ideology that would drive them towards the pursuit of any weapon (to include RDDs) in an effort to further their cause. An RDD could provide them with the ability to not only cause fatalities, but strike fear, panic, and economic destruction in the location where the attack takes place. The psychological effects could spread further than just the local area of the attack, even internationally, if people felt that they were also vulnerable to this type of an attack.

While an RDD attack has not been officially documented, there is one case where radiological material was used to kill. This was the 2006 murder of Alexander Litvinenko in London. Alexander's murder was accomplished by his ingestion of polonium-210 contaminated tea. While that delivery method is not what typically comes to mind with an RDD, it does show that material can be obtained and used to cause death.

There are several factors that interfere and cause challenges with the use of RDDs, to include dirty bombs. These include the ability to obtain materials, the technology to incorporate them in to a conventional munition, and the ability to effectively deliver the RDD. However, this does not imply that it is not a security concern. Information indicates that organizations claim they either have built devices or they promote the development of such devices through their websites.

Certain types of materials may be easier to obtain (such as those stored in areas with less stringent controls and management).

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